Flavonols

KARRIE HENEMAN, Assistant Project Scientist, Department of Nutrition, University of California, Davis; SHERI ZIDENBERG-CHERR, UC Cooperative Extension Nutrition Science Specialist, Department of Nutrition, University of California, Davis

What are flavonols?
Flavonols are phytochemical compounds found in high concentrations in a variety of plant-based foods and beverages. Based on their structure, flavonols are classified as flavonoids and include the following compounds: quercitin, kaempferol, and myricetin. The specific amounts of flavonols in foods are affected by a range of factors including plant type and growth, season, light, degree of ripeness, food preparation, and processing. Despite these variables, high concentrations of flavonols can be found in apples, apricots, beans, broad beans, broccoli, cherry tomatoes, chives, cranberries, kale, leeks, pear, onions, red grapes, sweet cherries, and white currants (1).

What is the flavonol content of some common foods? (2)

<table>
<thead>
<tr>
<th>Food</th>
<th>Quercitin (mg/100g)</th>
<th>Kaempferol (mg/100g)</th>
<th>Myricetin (mg/100g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>apples</td>
<td>4.27</td>
<td>0.02</td>
<td>0.00</td>
</tr>
<tr>
<td>apricots</td>
<td>2.08</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>beans</td>
<td>0.00</td>
<td>31.32</td>
<td>0.00</td>
</tr>
<tr>
<td>broad beans</td>
<td>0.55</td>
<td>0.35</td>
<td>0.00</td>
</tr>
<tr>
<td>broccoli</td>
<td>2.51</td>
<td>0.01</td>
<td>4.01</td>
</tr>
<tr>
<td>cherry tomatoes</td>
<td>2.76</td>
<td>0.10</td>
<td>0.00</td>
</tr>
<tr>
<td>chives</td>
<td>4.77</td>
<td>10.00</td>
<td>0.00</td>
</tr>
<tr>
<td>cranberries</td>
<td>15.09</td>
<td>0.09</td>
<td>6.78</td>
</tr>
<tr>
<td>kale</td>
<td>7.71</td>
<td>26.74</td>
<td>0.00</td>
</tr>
<tr>
<td>leeks</td>
<td>0.10</td>
<td>2.95</td>
<td>0.00</td>
</tr>
<tr>
<td>pear</td>
<td>4.51</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>onions</td>
<td>21.42</td>
<td>0.62</td>
<td>0.02</td>
</tr>
<tr>
<td>red grapes</td>
<td>1.38</td>
<td>0.00</td>
<td>0.01</td>
</tr>
<tr>
<td>sweet cherries</td>
<td>2.64</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>tea</td>
<td>2.74</td>
<td>0.88</td>
<td>0.89</td>
</tr>
<tr>
<td>white currant</td>
<td>2.68</td>
<td>0.17</td>
<td>0.18</td>
</tr>
</tbody>
</table>

Are there beneficial effects associated with consumption of flavonols?
Consumption of flavonols has been associated with a variety of beneficial effects including increased activity of erythrocyte superoxide dismutase (an antioxidant enzyme found in red blood cells), a decrease in lymphocyte DNA damage, a decrease in urinary 8-hydroxy-2’-deoxyguanosine (a marker of oxidative damage), and an increase in plasma antioxidant capacity (the ability to scavenge free radicals) (3).
There seems to be a lot of media hype around apples, broccoli, and cranberries. Are these really “super foods”?

As shown in the above table, apples, broccoli, and cranberries are all high in flavonols, in addition to a variety of other polyphenolic compounds. Below is a summary of the research on the effects of consuming these foods:

**Apples**

Studies have investigated the relationship between consumption of apples and susceptibility to chronic diseases such as cancer, cardiovascular disease, asthma, and diabetes (4).

- **Cancer:** A reduced risk of oral, pharynx, esophagus, colon, larynx, breast, ovary, and prostate cancer has been observed in individuals who consume greater than or equal to one apple a day in comparison to those who consume less (5). In support of these findings, previous research on in vitro systems has found that apple flavonoids can positively affect carcinogen bioactivation, cell-signaling, cell cycle regulation, angiogenesis (the formation of blood vessels), oxidative stress, and inflammation (5).

- **Cardiovascular Disease:** Consumption of apples has been associated with a reduced risk of cardiovascular disease, cardiovascular events, coronary mortality, and thrombotic stroke (4).

- **Asthma:** In adults, a reduced risk of asthma, bronchial sensitivity, and chronic obstructive pulmonary disease in addition to improved lung function (as measured by forced expiratory volume) has been associated with apple consumption (4).

- **Diabetes:** Apple consumption has also been associated with a reduced risk of type 2 diabetes. In comparison to women who did not consume apples, consumption of at least one apple per day was associated with a 28 percent reduced risk of this chronic disease (6).

- **Conclusions:** Current research supports an inverse relationship between consumption of apples and a variety of chronic diseases. In light of these findings, consuming an apple a day as part of your recommended intake of fruits and vegetables may prove to be beneficial to overall health; however, variety is important and apples should not be the sole fruit consumed by an individual.

**Broccoli**

Cruciferous vegetables are part of the plant family Brassicaceae, which includes broccoli in addition to cabbage, cauliflower, Brussels sprouts, turnips, and watercress. Consumption of this group of plant foods has been associated with a reduction in risk of several cancers including lung, breast, colorectal, and prostate (7).

- **Cancer:** Epidemiological evidence supports an inverse association between consumption of broccoli and breast cancer risk in premenopausal women (8), prostate cancer (9), bladder cancer in men (10), lung cancer in postmenopausal women, colon cancer in postmenopausal women, cancer of the respiratory tract, stomach cancer in men, cancer of the reproductive organs in women, and thyroid cancer (11).

- **Conclusions:** In light of this research, the American Cancer Society recommends consuming broccoli (in any form, although raw broccoli contains the most nutrients) as part of a balanced diet that includes foods from a variety of plant sources.
**Cranberries**

Cranberries are commonly touted as a remedy for treating urinary tract infections. Current research has also investigated the relationship between consumption of cranberry products and cancer and cardiovascular disease.

- **Urinary Tract Infections:** Current scientific evidence suggests that use of cranberry products can prevent new urinary tract infections, possibly through inhibition of bacterial adhesion to the urinary tract (12). However, caution is warranted as cranberry juice may interact with warfarin (a blood thinner), resulting in bleeding (13).

- **Cancer:** Despite promising findings in experimental models suggesting that cranberries can protect against breast, colon, prostate, lung, and other tumors (14), current research on humans does not provide evidence that consumption of cranberry products reduces risk of cancer (15).

- **Heart Disease:** There is limited clinical evidence showing that consumption of cranberry products can protect against cardiovascular disease, possibly by decreasing LDL oxidation and increasing plasma antioxidant capacity (16).

- **Conclusions:** The Dietary Guidelines for Americans, 2005, recommend limiting consumption of juice to ensure adequate intake of fiber (31 grams per 2,000 kilocalories). (See the metric conversion table at the end of this publication.) For women prone to urinary tract infections, consuming \( \frac{1}{2} \) cup of cranberry juice daily may help to reduce the number of new infections. As with apples and broccoli, current scientific evidence supports consumption of cranberry products as part of a varied diet.

**METRIC CONVERSIONS**

<table>
<thead>
<tr>
<th>English</th>
<th>Conversion factor for English to metric</th>
<th>Conversion factor for metric to English</th>
<th>Metric</th>
</tr>
</thead>
<tbody>
<tr>
<td>grain</td>
<td>64.80</td>
<td>0.015</td>
<td>milligram (mg)</td>
</tr>
<tr>
<td>fluid ounce (fl oz)</td>
<td>29.57</td>
<td>0.034</td>
<td>milliliter (ml)</td>
</tr>
<tr>
<td>ounce (oz)</td>
<td>28.35</td>
<td>0.035</td>
<td>gram (g)</td>
</tr>
<tr>
<td>cup</td>
<td>236.6</td>
<td>0.004</td>
<td>milliliter (ml)</td>
</tr>
</tbody>
</table>

**REFERENCES**


FOR FURTHER INFORMATION
To order or obtain printed ANR publications and other products, visit the ANR Communication Services online catalog at http://anrcatalog.ucdavis.edu. You can also place orders by mail, phone, or FAX, or request a printed catalog of our products from:

University of California
Agriculture and Natural Resources
Communication Services
6701 San Pablo Avenue, 2nd Floor
Oakland, California 94608-1239
Telephone: (800) 994-8849 or (510) 642-2431
FAX: (510) 643-5470

E-mail inquiries: danrcs@ucdavis.edu

© 2008 The Regents of the University of California
Division of Agriculture and Natural Resources

All rights reserved.

No part of this publication may be reproduced, stored in a retrieval system, or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without the written permission of the publisher and the authors.

Publication 8317

Production of this material was supported by a grant from the Vitamin Cases Consumer Settlement Fund, created as a result of an antitrust class action. One of the purposes of the fund is to improve the health and nutrition of California consumers.

The University of California prohibits discrimination or harassment of any person on the basis of race, color, national origin, religion, sex, gender identity, pregnancy (including childbirth, and medical conditions related to pregnancy or childbirth), physical or mental disability, medical condition (cancer-related or genetic characteristics), ancestry, marital status, age, sexual orientation, citizenship, or service in the uniformed services (as defined by the Uniformed Services Employment and Reemployment Rights Act of 1994: service in the uniformed services includes membership, application for membership, performance of service, application for service, or obligation for service in the uniformed services) in any of its programs or activities.

University policy also prohibits reprisal or retaliation against any person in any of its programs or activities for making a complaint of discrimination or sexual harassment or for using or participating in the investigation or resolution process of any such complaint.

University policy is intended to be consistent with the provisions of applicable State and Federal laws.

Inquiries regarding the University’s nondiscrimination policies may be directed to the Affirmative Action/Equal Opportunity Director, University of California, Agriculture and Natural Resources, 1111 Franklin Street, 6th Floor, Oakland, CA 94607, (510) 987-0096. For information about ordering this publication, telephone 1-800-994-8849. For assistance in downloading this publication, telephone 530-754-3927.

An electronic copy of this publication can be found at the ANR Communication Services catalog Web site, http://anrcatalog.ucdavis.edu.

This publication has been anonymously peer reviewed for technical accuracy by University of California scientists and other qualified professionals. This review process was managed by the ANR Associate Editor for Food and Nutrition.

pr-11/08-LR/CR